

Introduction

All specifications in the following sections describe the instrument's warranted performance:

- Timing parameters
- Output parameters
- Waveform characteristics

All specifications apply with a $50\ \Omega$ load, after a 30 minute warm-up period, and are valid for ambient temperature in the range 15°C to 35°C . Refer to the General Characteristics section of this chapter for the performance derating factor to be used outside this temperature range (within the specified operating range of 0°C to 55°C) .

All operating characteristics given in the following sections describe typical performance figures which are non-warranted:

- Trigger modes
- Control modes
- Inputs and Outputs
- Additional features
- General characteristics

Timing Parameters

Unless otherwise stated, specifications are quoted for 50% amplitude in normal mode.

Frequency

Range

1.00 mHz to 50.0 MHz

Resolution

3 digits, best case 10 μ Hz (0.01 mHz)

Stability

$\pm 0.2\%$ (1 hour)

$\pm 0.5\%$ (24 hours)

Repeatability

Factor 4 better than accuracy

Accuracy

Frequency (FRQ)	Pulse mode or waveforms with 50% duty cycle	Waveforms with duty cycle \neq 50%
1 mHz \leq FRQ < 100 kHz	$\pm 3\% \pm 0.3$ mHz	$\pm 3\% \pm 0.6$ mHz
100 kHz \leq FRQ < 10 MHz	$\pm 5\%$	$\pm 10\%$
10 MHz \leq FRQ \leq 50 MHz	$\pm 5\%$	n/a
Jitter	< 0.1% + 100 ps	< 0.2% + 100 ps
RMS Jitter	0.03% + 30 ps	0.06% + 30 ps

Duty Cycle

Frequency (FRQ)	Range and Resolution	Accuracy
1 mHz \leq FRQ < 1 MHz	10% to 90% in steps of 1%	± 0.5 LSD*
1 MHz \leq FRQ < 10 MHz	20% to 80% in steps of 1%	± 3.0 LSD
10 MHz \leq FRQ \leq 50 MHz	50% fixed	± 5.0 LSD, typical

*Least Significant Digit (only units and tens are displayed)

Pulse Width

Range

10.0 ns to 999 ms

(Maximum = $1/\text{FRQ} - 10 \text{ ns}$)

Resolution

3 digits, best case 100 ps (0.1 ns)

Accuracy

$\pm 5\% \pm 2 \text{ ns}$

Repeatability

Factor 4 better than accuracy

Jitter

$0.2\% + 200 \text{ ps}$ (width $\leq 10 \mu\text{s}$)

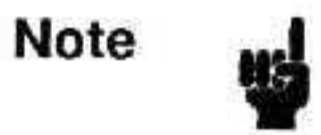
0.1% (width $> 10 \mu\text{s}$)

RMS Jitter

$0.06\% + 60 \text{ ps}$ (width $\leq 10 \mu\text{s}$)

$0.03\% + 30 \text{ ps}$ (width $> 10 \mu\text{s}$)

Output Parameters



Output voltages are specified for a 50 Ω load. Output voltages double when driving a high impedance load.

Output Impedance 50 Ω ± 2.5 Ω

Amplitude/Offset

Amplitude and offset are independently variable within the following two level windows:

Level window:	±800 mV	±8.00 V
Amplitude range	10.0 mV to 99.9 mV (p-p)	100 mV to 16.0 V (p-p)
Amplitude resolution	3 digits (best case 0.1 mV)	3 digits (best case 1 mV)
Amplitude accuracy*	± 5%	± 5%
Offset range	0 to ±795 mV	0 to ±7.95 V
Offset resolution	3 digits (best case 0.1 mV)	3 digits (best case 1 mV)
Offset accuracy	±1% of programmed value ±1% of amplitude ±4 mV	±0.5% of programmed value ±1% of amplitude ±40 mV
Repeatability	Factor 4 better than accuracy	

* The amplitude accuracy for sine and triangle is specified at 1 kHz. The following table specifies the amplitude flatness at other frequencies for an output signal with 50% duty cycle:

Amplitude Flatness

Frequency (FRQ)	Sine	Triangle
1 mHz ≤ FRQ < 1 MHz	±3%	±3%
1 MHz ≤ FRQ < 10 MHz	±5%	±5%
10 MHz ≤ FRQ ≤ 50 MHz	+5%, -15%	+5%, -25%

Waveform Characteristics

Sine The following specifications apply for normal output mode and 50% duty cycle.

Total Harmonic Distortion (THD) < 1% (-40 dB), (10 Hz to 50 kHz).
This may increase by 3 dB below 10°C.

Harmonic signals < 2% (-34 dBc*)
for 50 kHz ≤ FRQ < 1 MHz

< 7% (-23 dBc*)
for FRQ ≥ 1 MHz
and amplitude < 8 V (p-p)

* dBc = dB relative to carrier (fundamental).

Triangle

Linearity < ±3% (10% to 90% of amplitude
and 100 mHz ≤ FRQ < 1 MHz)

Square, Pulse

Transition time < 7 ns (10% to 90% of amplitude)

Pulse perturbations < ±5% of amplitude ±2 mV

Settling time 100 ns + transition time

DC Output

A dc output voltage is generated when all waveform selection keys are deactivated.

Range 0 mV to ±7.95 V

Resolution 3 digits, best case 1mV

Accuracy ±0.5% ±40 mV

Repeatability Factor 4 better than accuracy

Operating Characteristics

The following sections give non-warranted information on the instrument's typical operating characteristics:

- Trigger modes
- Control modes
- Inputs and Outputs
- Additional features
- General characteristics

Trigger Modes

The external trigger signal referred to in this section is applied to the **EXT INPUT** BNC connector on the instrument front panel. The trigger level and sense are adjustable. An external trigger can be simulated by pressing the **MAN** key.

The period and duty cycle of the first output cycle may deviate up to 10% from subsequent cycles.

Note



* indicates that in this mode the start phase of sine and triangle waveforms is selectable between 0° and -90° using the **-90°** key.

Normal

A continuous output waveform is generated.

In Normal mode, all parameters can be automatically incremented or decremented with selectable resolution. Pressing the **AUTO** key enables this **AUTO** vernier, which can then be started by pressing the required vernier key. The **AUTO** vernier is stopped by an external trigger input or by pressing the **AUTO** key again.

*Trigger

Each active input edge triggers a single output cycle.

*Gate

The active level of the external signal enables output cycles. The first output cycle is synchronous with the active trigger slope. The last output cycle is always completed. The **MAN** key can be used to simulate an external gate signal.

External Width

In pulse waveform mode only, the external signal is shaped to determine output pulse width. This mode can be used for pulse recovery. The amplitude and offset controls are active.

Logarithmic Sweep (Option 001)

For all waveforms the output signal frequency performs a logarithmic sweep between selected start and stop frequencies within the instrument's range (1 mHz to 50 MHz). The sweep time per decade is selectable between 10 ms and 500 s but restricted to intervals in the ratios 1:2:5. The sweep always starts with 0° output phase.

Internal sweep	Continuous sweep cycles.
External sweep	One sweep cycle is triggered by the external signal.
Marker frequency	Programmable, see Marker Output.
Sweep ramp voltage	See X-Output.

Counted Burst (Option 001)

The HP 8116A generates a preprogrammed number (1 to 1999) of output cycles. The maximum burst frequency in this mode is 40 MHz.

Internal burst:	Output bursts are repeatedly generated at programmable time intervals in the range 100 ns to 999 ms. This mode is not available in pulse waveform mode.
External burst:	An output burst is triggered by the external signal. The minimum time between burst triggers is 100 ns.

The **1 CYCLE** key can be used to initiate a single output cycle.

Control Modes

An external control signal applied to the **CTRL INPUT BNC** connector can be used to modulate the output signal.

Frequency Modulation

Deviation	$\pm 5\%$ maximum for ± 6 V input
Modulation bandwidth	dc to 20 kHz (FRQ < 10 MHz) dc to 3 kHz (FRQ \geq 10 MHz)

Amplitude Modulation

Modulation	100% with ± 2.5 V input DSBSC (Double Side Band Suppressed Carrier) with +2.5 V, -7.5 V input
Modulation bandwidth	dc to 1 MHz
Envelope distortion	< 1% for modulation depth < 90% (dc to 50 kHz and not complementary output)

Pulse Width Modulation

Modulation range	Maximum of one decade with ± 6.5 V input
Pulse width ranges	10 ns to 1 s in eight adjacent decade ranges

Voltage Controlled Oscillator

The external voltage signal linearly sweeps the output frequency through two complete decades.

Modulation range	Maximum of two decades with 0.1 V to 10 V input. 11 overlapping ranges from 1 mHz to 50 MHz with 2 decades per range. Display shows the maximum frequency in the current range.
Modulation bandwidth	dc to 1 kHz

Output modes

Complement

Selectable on/off

Disable

Disconnects output, default on switching on.


Limit

Implements present output levels as output limits.

Hold (Option 001)

External hold signal freezes output at current level. This mode only applies at frequencies < 10 Hz. In hold mode the output droop is $< 0.01\%$ of the amplitude per second.

Inputs and Outputs

External Input	Threshold level	± 10 V adjustable
	Trigger slope	Positive or negative or trigger off
	Minimum amplitude	500 mV (p-p)
	Input voltage limits	± 20 V
	Minimum pulse width	10 ns
	Input impedance	10 k Ω
Control Input	Input voltage limits	± 20 V
	Input impedance	10 k Ω
Hold Input (Option 001)	Hold level	> 2.5 V, or open circuit
	Run level	< 2.5 V
	Input voltage limits	± 20 V
	Input impedance	10 k Ω
Main Output	Range	± 8 V into 50 Ω
	Output Impedance	50 $\Omega \pm 2.5 \Omega$
	External voltage limits	Do not apply external voltage
	Short circuit capability	Maximum peak current 320 mA for up to 1 hour (15°C to 35°C)
Trigger Output	High level	2.4 V into 50 Ω
	Low level	0 V
	Active edge	Positive
	Output impedance	50 Ω
	Propagation Delay	60 ns
		(EXT INPUT to TRIG OUTPUT)
	External voltage limits	0 V, +5 V
Duty cycle	Dependant on main output signal	

Marker Output (Option 001)	High level	2.4 V into 50 Ω
	Low level	0 V
	Edges	Positive at marker frequency
		Negative at start of sweep
	Output impedance	50 Ω
	External voltage limits	0 V, +5 V
X-Output (Option 001)	Levels	0 V to 10 V, 1.5 V per sweep decade into high impedance.
	Output impedance	1 k Ω
	External voltage limits	0 V, +5 V

Additional Features

HP-IB Capability

The HP 8116A is fully programmable except for the External Input trigger level.

Capability codes

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1

Learn mode

All or individual parameters can be programmed

Learn string

Total 89 characters (161 characters with Option 001).

Message Interpretation times

Modes	30 ms
Timing parameters	50 ms
Voltages	250 ms

Execution times

5 ms (Offset 30 ms)

Transmission times

Status	15 ms
Learn string	1 ms per character

Self-test

The instrument performs a self-test when switched on, and by HP-IB command.

Memory

The current settings are stored when the instrument is switched off.

Error detection

The instrument indicates incompatible settings on the front panel and via the status byte.

General Characteristics

Environmental

Storage temperature range	-40°C to 70°C
Operating temperature range	0°C to 55°C
*Specification temperature range	15°C to 35°C
Humidity range	Up to 95% R.H., 0°C to 40°C

* The accuracy specification derating factor for temperatures outside this range is $1 + 0.05 \times d^{\circ}\text{C}$ where $d^{\circ}\text{C}$ is the temperature deviation below 15°C or above 35°C.

Power supply

- 100/120/220/240 V rms (selectable) +5%, -10%
- 48-440Hz
- 120 VA maximum

Weight

Net	5.9 kg (13 lbs)
Shipping	11.0 kg (24.4 lbs)

Dimensions

- 89 mm high (3.5 in)
- 213 mm wide (8.4 in)
- 450 mm deep (17.7 in)

Recalibration period

1 year recommended